NASA SBIR/STTR Technologies

X11.01: Crew Exercise System
ESPRIT: Exercise Sensing and Pose Recovery Inference Tool
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Identification and Significance of Innovation

Crew exercise is important for maintaining health and fitness of astronauts, especially in preventing adverse health problems associated with long-duration space flight, such as losses in muscle strength and endurance, bone density, balance and aerobic capacity. Monitoring of crew health and fitness is therefore important, and this includes performing motion capture and kinematic analysis to understand the effect of microgravity on exercise, and ensure that the exercise prescription (ExRx) is effective. Existing motion capture systems have been used in the entertainment industries and for biomechanical research but such systems are bulky and impractical for ISS.

We have developed an exercise monitoring system called **ESPRIT: Exercise Sensing and Pose Recovery Inference Tool**. This is a stereo camera system that monitors exercise activities, detects markers placed on the body, extracts image features, and recovers 3D kinematic body pose. ESPRIT uses strong prior knowledge and modeling of human body, pose, dynamics, and appearance. Preliminary result has been promising and has demonstrated motion capture of several exercises, including walking, curling and dead lifting.
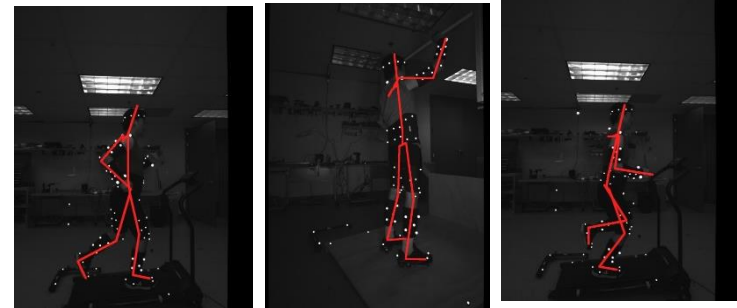
ESPRIT System with result on stereo camera motion capture with different types of exercise .

Technical Objectives and Work Plan

The technical objectives are.
- Develop an ESPRIT prototype system to perform 3D motion capture from stereo.
- Conduct detailed performance evaluation with comparison of joint location estimation from commercial multi-camera motion capture system.
- Conduct technical demonstration of the prototype in a representative environment.

The work plan includes the following tasks.
Task 1: Perform requirement capturing and prototype system design.
Task 2: Perform algorithm enhancement for 3D motion capture.
Task 3: ESPRIT Software Development.
Task 4: Conduct performance evaluation and enhancement.
Task 5: ESPRIT Prototype integration and testing in a representative environment.
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NASA and Non-NASA Applications

Potential NASA Commercial applications
ESPRIT system will support NASA's Exercise Countermeasure Project for observing crew's exercise activities, performing 3D motion capture and kinematic analysis.

Potential Non-NASA Commercial applications
Non-NASA applications include uses in medicine and rehabilitation, such as gait analysis, orthopedics, and other applications for monitoring skeletal movement. Other applications include simulation, immersive reality, video games, personal fitness, human-robotics and human-computer interaction.

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NON-PROPRIETARY DATA